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Performance evaluation of tractor drawn happy seeder for sowing of wheat crop and comparative study with other sowing machines

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Abstract
Rice-wheat cropping pattern is common in most of the state in India and it is also adopted in many district of the of Madhya Pradesh. Now a day, in mechanized farming system the happy seeder machine is used for sowing of wheat after harvesting of paddy by combine harvester. To check the feasibility of happy seeder machine, the scientific study is needed. Therefore, research was conducted in JNKVV, Jabalpur on feasibility study of happy seeder machine and compared the performance of happy seeder with the zero till drill machine as well as conventional method of seeding. Total nine feasibility testing trails of tractor drawn happy seeder were conducted in 18.40 ha area. The field efficiency in different treatment varied from 52.80 to 82.53 percent and actual field capacity was in the range of 0.28 to 0.416 ha/h. The field capacity i.e. 0.28 ha/h was recorded in case of happy seeder and corresponding field efficiency was found 52.80%. Draft requirement for seed drill was 4.98 KN whereas, for happy seeder it was 7.2 KN. Total time saving was found 71.84% and 79.17% in treatment T_1 and T_2 respectively over conventional method. The highest fuel consumption of 17.94 l/ha was recorded in happy seeder. Total fuel saving was found 63.02% and 80.21% in treatment T_1 and T_2 respectively over conventional method. Total labor saving was found 76.92% and 80.70% in treatment T_1 and T_2 respectively over conventional method. Total saving in cost of operation was found 65.53% and 78.09% in treatment T_1 and T_2 respectively over conventional method. Total energy saving was found 71.74% and 82.52% in treatment T_1 and T_2 respectively over conventional method. Thus the performance of happy seeder was found satisfactory when compared with the zero till drill and conventional seed drill machine.

Keywords: Happy seeder machine, performance evaluation, stubble burning, testing happy seeder, paddy wheat mechanization, paddy sowing

1. Introduction

The rice-wheat farming system is the most dominant and profitable farming system in the Indo-Gangetic Plain region of north-west India. Rice-wheat rotation has been heavily supported by both national and provincial governments through a range of input subsidies (machinery, fertilizer, water, electricity and credit) (Davenport *et al*. 2009) [15] and price support mechanisms (USDA 2004). The majority of the rice in M.P. is mechanically harvested, leaving heavy loads (more 6 tonnes per hectare) of anchored straw and loose straw in windrows. With short time frames between the harvesting of rice and sowing the proceeding wheat crop, farmers have managed high stubble loads through the practice of burning. Burning of rice stubbles is widely practiced in M.P., India, due to lack of suitable machinery to direct drill wheat into combine-harvested rice residues. Although burning is a rapid and clean option, and allows quick turnaround between crops, it has serious effects on human and animal health due to air pollution, reduced soil fertility due to loss of nutrients and organic matter, and greenhouse gas (GHG) emissions.

The ICAR has been supporting the development of sustainable alternatives to stubble burning principally through the development of a direct drilling machine known as the happy seeder. The happy seeder is a tractor-powered machine that cuts and lifts the rice straw, sows into the bare soil, and deposits the straw over the sown area as a mulch. The happy seeder thus combines stubble mulching and seed and fertilizer drilling into a single pass (Sidhu *et al*. 2007, 2008) [3]. By use of this new technology, the farmers can incorporate crop residues results in improving soil health. The certain advantage of happy seeder machine are saving of irrigation water, seed, fertilizer, energy and cost of production of crops has been recorded with crop residue conservation technologies.

Therefore, acceleration of adoption of conservation agriculture technologies at farm level and development and evaluation of new machine like happy seeder for conserving crop residue and soil health is necessary.

In the research work undertaken, through the feasibility testing of happy seeder machine under FIM Scheme of AICRP at Jabalpur Centre, we were checking suitability of machine for this region, and to encourage the adoption of alternative stubble management practices in the M.P. region (like the Happy Seeder) with the aim of reducing the incidence of stubble burning. The primary aim of research work through feasibility testing was to evaluate field performance of happy seeder for sowing of wheat crop in combine harvested paddy field and to compare performance of happy seeder with the zero till drill machine as well as conventional method of seeding.

2. Materials and Methods

The happy seeder and zero till drill were evaluated for wheat sowing directly after harvesting of paddy by combine harvester at JNKVV experimental Farm. The paddy crops in the experimental and farmers' fields were harvested by combine. The soil of the experimental field was vertisol black cotton soil. The conventional seed drill method was used for wheat sowing for comparison purpose.

2.1 Constructional details of happy seeder

Happy seeder consists of a rotor for managing the paddy residues and a zero till drill for sowing of wheat. Flail type straight blades are mounted on the straw management rotor which cuts (hits/shear) the standing stubbles/ loose straw coming in front of the sowing tine and clean each tine twice in one rotation of rotor for proper placement of seed in the soil. The flails pushes the residues as surface much between the seeded rows. This PTO driven machine can be operated with 50 HP tractor and can cover 0.3-0.4 ha/hr. The major functional components of happy seeder consist of Frame, Furrow openers, Rotating Flails, Seed and fertilizer boxes, Seed metering mechanism, Seed rate adjusting lever, Seed pipe, Seed boot, Fertilizer metering system, Drive Wheel, Depth control wheel and Press Wheel.

Table 1: Specifications of tractor drawn happy seeder machine

Sr. No.	Particulars	Value of parameters
1.	Power source required	45 to 50 hp
2.	Hitch Type	Three point linkage, CAT-I/CAT-II
3.	No. of tynes	11
4.	Row to row distance	225 mm
5.	Type of furrow openers	Inverted T-type
6.	Rotor drum diameter	700-800 mm
7.	Rotor shaft diameter	130-150 mm
8.	Rotor RPM	1500-1600rpm at 540rpm of tractor PTO
9.	Types of flail blades	Reversible straight gamma type
10.	Flail blade length from rotor surface	240 mm
11.	Flail blade length	85 mm
12.	Top width of blade	50 mm
13.	Blade overlapping above furrow openers	60 mm
14.	Minimum diameter of ground wheel	550 mm
15.	Seed hopper	Separate hoppers (trapezoidal shape) for fertilizer and seeds with mechanism for feed rate control. The hoppers should be sufficiently covered to prevent the entry of water. If the material of fertilizer and seed box is mild steel, the thickness of MS sheet should be more than 1.0mm
	Metering Mechanism	
16.	For seeds	Fluted roller (as per IS 6813:2000)
17.	For fertilizer	Gravity feed or corrugated roller type
18.	Power to metering mechanism	From lugged ground wheel through chains and sprockets
19.	Seed and fertilizer tubes	Seed and fertilizer tubes should be made of transparent plastic. The thickness of the plastic tubes shall be a minimum of 25mm. length of plastic tube should be of suitable length without any bends.

2.2 Parameters recorded and determined during feasibility testing of happy seeder

2.2.1 Soil Parameters

Soil physical parameters soil type, moisture content (%), cone index (kPa), bulk density (Mg/m^3), macro nutrients (NPK) etc. were determined. The moisture content and bulk density of soil before sowing operation was the average moisture content at 0-15 cm depth was found to be 18.20%. Average bulk density was observed 1.36 g/cc and porosity was measured 50.63% before sowing of wheat by sowing machines.

2.2.2 Field performance parameters

Draft (N), speed of operation (km/h), actual time taken (h/ha), fuel consumption (l/ha), field capacity (ha/h), field efficiency (%), sowing depth (cm), planting depth (cm), seed to seed spacing (cm), plant population (No./m^2), variation in plant spacing (cm), Fuel consumption (l/h)

2.2.2.1 Determination of Theoretical field capacity (TFC)

The theoretical field capacity was calculated using the relationship.

$$TFC = (W \times S) / 10$$

Where,

TFC= theoretical field capacity, ha/h

W= Width of equipment, m

S= Speed of operation, km/h

2.2.2.2 Determination of Effective field capacity (EFC)

The actual field capacity was calculated using the relationship given below

EFC = (W x L) / (T X 10000)

Where,

EFC= theoretical field capacity, ha/h

W= Width of field coverage, m

L= Length of field coverage, m

T= Time for covering area, hours

2.2.2.3 Determination of Field efficiency (FE)

The field efficiency is the ratio of effective field capacity (ha/h) to the theoretical field capacity (ha/h).

FE = (EFC / TFC) x 100

Where,

TFC= Theoretical field capacity, ha/h

EFC= Theoretical field capacity, ha/h

FE= Field efficiency,%

2.2.2.4 Determination of Fuel consumption

For fuel consumption an auxiliary tank of capacity 3 liters having the marking of 50 ml apart is used. The auxiliary tank was connected to the intake and over flow fuel line. The decrement in the level of the fuel, area covered and time of operation was recorded after each treatment.

2.2.3 Miscellaneous parameters

Labour required (man-h/ha), cost of operation (Rs/ha), breakdown of equipment, remarks of farmers etc.

2.3 Evaluation of happy seeder, zero till drill and conventional seed drill

Wheat was sown with the happy seeder into standing rice residue or bare soil in three days in vertisol soil. The previous rice crop had been harvested with a combine harvester with a cutting height 50 to 60 cm. Average rice dry straw load in each experiment were varied from 5.3 to 6.66 t/ha dry at the time of rice harvest. In other field the wheat was sown by the conventional seed drill.

Fig 1: Views of happy seeder during sowing of wheat in paddy harvested field

Fig 2: Views of zero till drill and conventional seed drill during sowing of wheat in paddy harvested field

2.4 Experimental Design
The factorial RBD method was used for statistical analysis with following Treatments.

T_1: Combine harvesting + happy seeder (keeping loose straw in field)

T_2: Combine harvesting + Zero till drill (after removal of loose straw)

T_3: Traditional method (2 harrowing + 2 cultivators +1 planking+ seed drill)

For sowing of next crop wheat after paddy and to manage straw of combine harvested paddy field, the different machinery were tried which includes- T_1 = happy seeder, T_2 = Zero till drill, T_3= 2 times harrowing+2 times cultivating + planking and sowing by conventional seed drill.

Table 2: Details of feasibility testing trials conducted of happy seeder at JNVV & farmers field

S. No	Location	Village/V.V. Location	No. of Trials	Total covered area (ha)
1.	Farmer's field	Pipariya	01	1.80
2.	Farmer's field	Ganiyari	01	1.40
3.	Farmer's field	Gudganwa	02	1.50
4.	Farmer's field	Suhagi	01	1.80
5.	Farmer's field	Suhagi	01	1.90
6.	BSP Unit	JNKVV, JBP	02	5.20
7.	FC Unit	JNKVV, JBP	01	4.80
	Total		09	18.40

3. Results and discussion
In research work total nine feasibility trails of tractor drawn happy seeder were conducted in 18.40 ha area. The trails were conducted at JNKVV farms in 10 ha and 8.40 ha area at farmer's field. The performance parameter determined for happy seeder, zrero till drill and conventional seed drill evaluation were actual field capacity, field efficiency fuel consumption and cost of operation. The result data obtained shown in Table 3,4,5,6 and 7.

3.1 Time required
Time required under different treatments are given in table 3 below, it varied from 2.64 h/ha to 12.68 h/ha for different treatments. The maximum time required 12.68 h/ha was with treatment T_3 because in treatment T3 we were used 2 times harrowing, 2 times cultivating and 1 time planking operations followed by drilling with seed drill. The minimum time required 2.64 ha was with treatment T_2 (zero till drill) as no other machine used before sowing by zero till drill. The time required for happy seeder was 2.43 h /ha (T_2) which was higher than zero till drill as machine is heavy and takes little bit more time for sowing operation.

Table 3: Time required for sowing under different treatments

Treatments	Time required (h/ha)				Average time required (h/ha)
	R1	R2	R3	R4	
T_1	3.56	3.52	3.58	3.62	3.57
T_2	2.70	2.61	2.64	2.61	2.64
T_3	12.84	12.82	12.85	12.83	12.68

3.2 Straw height
In combine harvested field the straw height was 30.2 cm and after operation of different implements the straw height reduced from 30.2 cm to as low as 5.64 cm (total 81.2% reduction) in treatment T_1 (Happy seeder) as rotating flails are provided in happy seeder to manage straw. In case of zero till drill i.e. treatment T_2 the straw height reduced from 29.8 cm to 29.6 cm (0.67% reduction) which is lowest as no straw management arrangement provided in zero till drill machine. The reduction of straw height was found 71.42% in Treatment1, in sowing of wheat crop as harrow, cultivator and planking manage straw. Total reduction in straw height was found 81.2%, 0.67% and 71.42% in treatment T1, T2 and T3 respectively over conventional method. (Refer Table 4 and Fig.3).

Table 4: Straw height reduction under different treatments

Treatments	Straw height before operation (cm)	Straw height after operation(cm)	Straw height reduction (%)
T_3	30.2	8.63	71.42
T_2	29.8	29.6	0.67
T_1	30.1	5.64	81.2

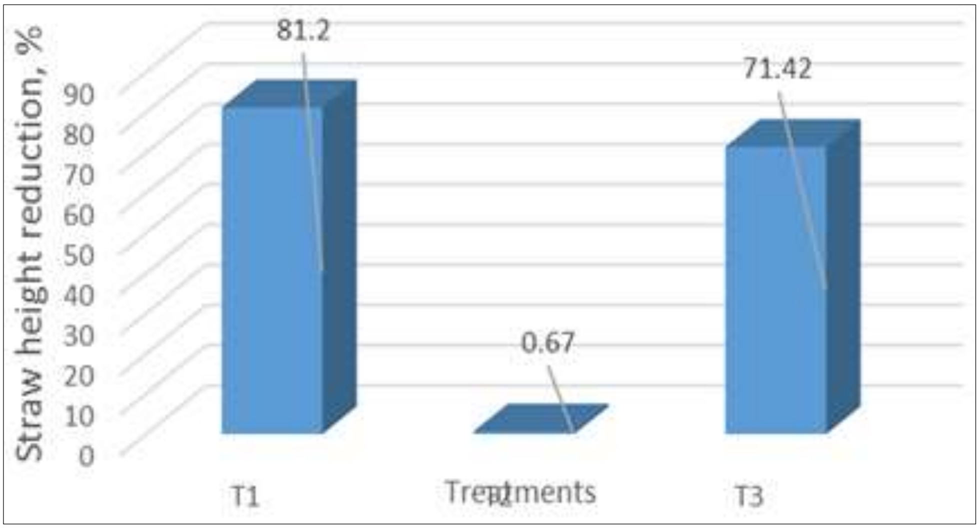

Fig 3: Straw height reduction under different treatments

3.3 Comparative study of performance of happy seeder with other machines

The field efficiency in different treatment varied from 52.80 to 82.53 percent and actual field capacity was in the range of 0.28 to 0.416 ha/h (Refer Table 5, 6 and 7). The field capacity i.e. 0.28 ha/h was recorded in case of happy seeder and corresponding field efficiency was found 52.80%. The highest field capacity i.e. 0.410 ha/h was recorded in case of conventional seed drill. The highest fuel consumption of 48.51 l/ha was observed in case of treatment T_3 (seed drill) as many machines involved to prepare field before sowing by seed drill. Draft requirement for disc harrow was 3.98 KN whereas, for happy seeder it was 7.2KN. Draft requirement for seed drill was 4.98 KN whereas, for happy seeder it was 7.2 KN. Draft required is higher as machine has additional mechanism for straw management which increases its overall weight. Total time saving was found 71.84% and 79.17% in treatment T_1 and T_2 respectively over conventional method. The highest fuel consumption of 17.94 l/ha was recorded in happy seeder. Total fuel saving was found 63.02% and 80.21% in treatment T_1 and T_2 respectively over conventional method. Total labor saving was found 76.92% and 80.70% in treatment T_1 and T_2 respectively over conventional method. Total saving in cost of operation was found 65.53% and 78.09% in treatment T_1 and T_2 respectively over conventional method. Total energy saving was found 71.74% and 82.52% in treatment T_1 and T_2 respectively over conventional method. (Refer Figures 2, 3, 4, 5, 6 and 7).

Table 5: Comparative performance of happy seeder, zero till drill and conventional seed drill during wheat sowing.

S. No.	Performance parameters	Happy Seeder	Zero till drill	Conventional drill
1	Effective working width, cm	207	180	180
2	Operating speed, km/h	2.6	2.7	2.8
3.	Theoretical field capacity, ha/h	0.538	0.486	0.504
4.	Actual time required, h/ha	3.57	2.64	2.40
5.	Effective field capacity, ha/h	0.280	0.381	0.416
6.	Field efficiency,%	52.83	78.40	82.53
7.	Draft requirement, KN	7.2	5.40	4.98
8.	Moisture content,%	18.24	18.36	18.84
9.	Avg. bulk density of soil (before sowing), g/cc	1.36	1.36	1.36
10.	Total time required, h/ha	3.57	2.64	12.68
11.	Time saving,%	71.84	79.17	-
12.	Fuel consumption, l/ha	17.94	9.60	48.52
13.	Fuel saving,%	63.02	80.21	-
14.	Labour requirement, man-h/ha	6	5	26
15.	Labour saving,%	76.92	80.76	-
16.	Germination,%	88	86	92
17.	Cost of sowing, Rs/ha	6200	3952	18040
18.	Saving in cost of sowing,%	65.53	78.09	-
19.	Energy requirement, MJ/ha	756.32	467.62	2676.32
20.	Energy saving,%	71.74	82.52	-
21.	Yield, q/ha	38.10	34.2	35.10
22.	Reduction in straw height,%	81.2	0.67	71.42

Table 6: Actual field capacity of happy seeder, zero till drill and conventional seed drill during wheat sowing.

Implements	Actual field capacity (ha/h)				Average actual field Capacity (ha/h)
	R1	R2	R3	R4	
Happy seeder	0.24	0.26	0.29	0.33	0.280
Zero till drill	0.38	0.37	0.39	0.384	0.381
Conventional seed drill	0.40	0.39	0.426	0.448	0.416

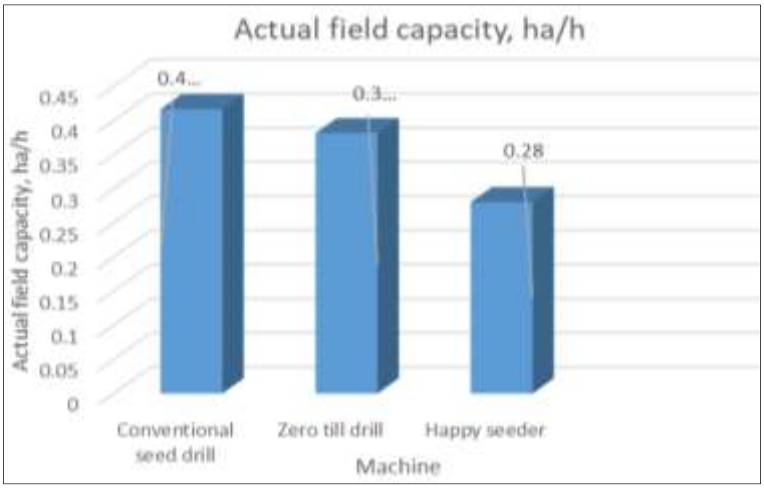

Fig 4: Actual field capacity of happy seeder, zero till drill and conventional seed drill during wheat sowing.

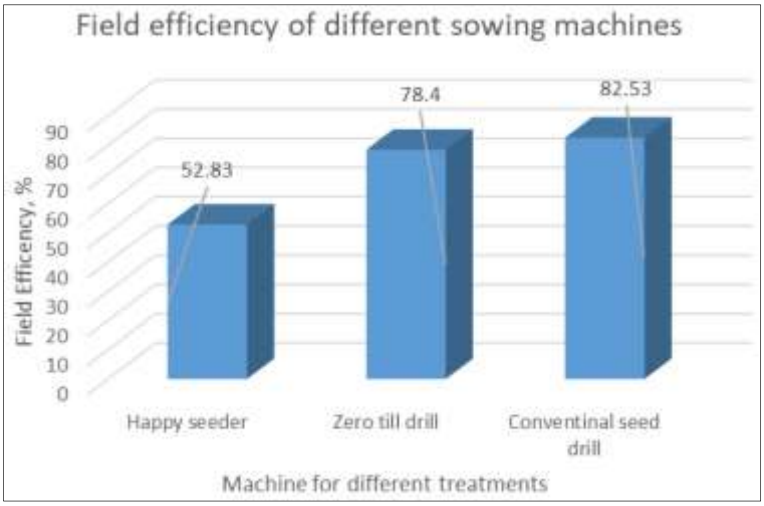

Fig 5: Field efficiency of happy seeder, zero till drill and conventional seed drill during wheat sowing.

Table 7: Fuel consumption of happy seeder, zero till drill and conventional seed drill during wheat sowing under different treatments

Treatments	Fuel consumption (l/ha)				Average fuel consumption (l/ha)
	R1	R2	R3	R4	
T_1	18.9	17.1	18.6	18.76	17.94
T_2	9.80	8.96	9.12	8.31	9.60
T_3	47.92	48.6	48.5	49.7	48.52

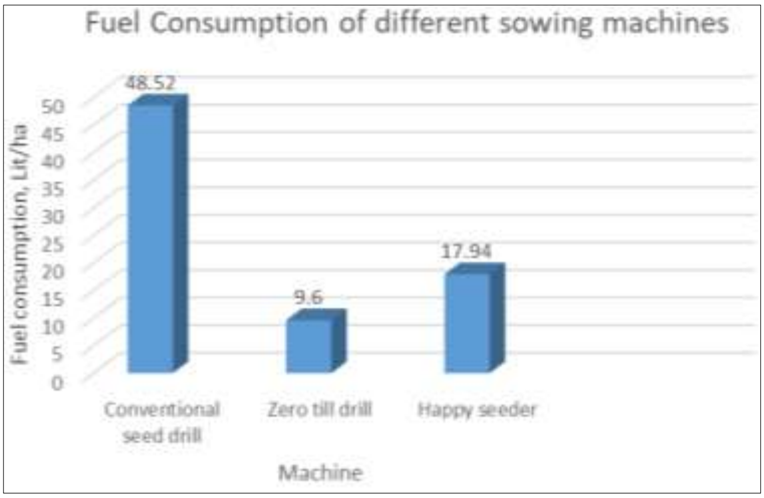

Fig 6: Fuel consumption of happy seeder, zero till drill and conventional seed drill during wheat sowing.

Fig 7: Views of wheat crop sown by happy seeder in paddy harvested field.

4. Conclusions

In this research work undertaken the nine feasibility testing trails of tractor drawn happy seeder were conducted in 18.40 ha area (JNKVV farms10 ha and farmer's field 8.40 ha). The draft requirement for happy seeder it was 7.2KN. The field capacity i.e. 0.28 ha/h was recorded in case of happy seeder and corresponding field efficiency was found 52.80%. The field efficiency in different treatment varied from 52.80 to 82.53 percent and actual field capacity was in the range of 0.28 to 0.416 ha/h (Refer Table 5, 6 and 7). Total time saving was found 71.84% and 79.17% in treatment T_1 and T_2 respectively over conventional method. Total reduction in straw height was found 81.2%, 0.67% and 71.42% in treatment T_1, T_2 and T_3 respectively over conventional method. Total fuel saving was found 63.02% and 80.21% in treatment T_1 and T_2 respectively over conventional method. Total labor saving was found 76.92% and 80.70% in treatment T_1 and T_2 respectively over conventional method. Total saving in cost of operation was found 65.53% and 78.09% in treatment T_1 and T_2 respectively over conventional method. Total energy saving was found 71.74% and 82.52% in treatment T_1 and T_2 respectively over conventional method. Hence, the performance of happy seeder was found satisfactory when compared with the zero till drill and conventional seed drill machine. Thus, it is concluded that rice residue is largely burnt due to unavailability of the proper machinery for planting wheat into loose rice residue. The Happy Seeder technology overcomes this problem of planting wheat into the loose residue. Further happy seeder is the most efficient method to reduce the cost of production and manages the combine harvested paddy straw.

5. Acknowledgement

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6. References

1. Saunders C, Davis L, Pearce D. Centre for international economics rice–wheat cropping systems in India and Australia, and development of the 'Happy Seeder'. Aciar impact assessment series. 2012;77:27-28.
2. Naresh RK, Singh SP, Deepesh Kumar, Bhanu Partap. Experience with managing rice residues in intensive rice-wheat cropping system in North- West-ern India. International J Life Sci. Biotechnology and Pharma Research. 2013;2:85-96.
3. Sidhu HS, Singh M, Humphreys E, Singh Y, Singh B, Dhillon SS, *et al*. The happy seeder enables direct drilling of wheat in to rice stubble. Australian Journal of Experimental Agriculture. 2007;47:844-854.
4. Singh A, Kang JS, Kaur M. lanting of wheat with happy seeder and rotavator in rice stubbles. Indo-Am. J Agric. & Vet. Sci. 2013;1(2):32-41.
5. Singh H, Raheja A, Sharma R, Singh J, Kaur T. Happy seeder - a conservation agriculture technology for managing rice residue for Central Punjab conditions. Int J of Agril. Eng. 2013;6(2):355-358.
6. Singh RP, Dhaliwal HS, Humphreys E, Sidhu HS, Singh M, Singh Y, *et al*. Economic assessment of the Happy Seeder for rice-wheat systems in Punjab, India', Contributed Paper to the 52nd Annual Conference of the Australian Agricultural and Resource Economics Society, Canberra, 6-8 February; c2008.
7. Dhillon GS. Comparative evaluation of happy seeder technology versus normal sowing in wheat (Triticum aestivum) in adopted village Killi Nihal Singh of Bathinda district of Punjab. J Appl and Nat Sci. 2016;8(4):2278-2282.
8. Jat ML, Kamboj BR, Sidhu HS, Singh M, Bana A, Bishnoi DK, *et al*. Operational manual for Turbo Happy Seeder-Technology for managing crop residues with environmental stewardship; c2013.
9. Yadvinder-Singh, Bijay-Singh, Timsina J. Crop residue management for nutrient cycling and improving soil productivity in rice based cropping systems in the tropics. Advances in Agronomy. 2005;85:269-407. doi: 10.1016/S0065-2113(04)85006-5.
10. Shukla LN, Sidhu HS, Bector V. Design and development of a loose straw thrower for direct drilling machine. Agriculture Engineering Today. 2003;26(3-4):23-29.
11. Timsina J, Connor DJ. Productivity and management of rice–wheat cropping systems: issues and challenges. Field Crops Research. 2001;69:93-132. doi: 10.1016/S0378-4290(00)00143-X.
12. RWC. The rice–wheat consortium for the Indo Gangetic Plains-Highlights 2003-04. (RWC-CIMMYT: New Delhi); c2004. Available at www.rwc-prism.cgiar.org/rscrtcc/index.asp [Verified 22 April 2007].
13. OFWM. 'Impact assessment of resource conservation technologies (rice–wheat) DFID Project 1999-2002.' (Directorate General Agriculture Water Management: Lahore); c2002.
14. Humphreys E, Blackwell J, Sidhu HS, Malkeet-Singh, Sarbjeet-Singh, Manpreet-Singh, *et al*. Direct drilling into heavy stubbles – the Happy Seeder. Farmers' Newsletter Large Area No. 2006;172:4-7. Available at http://www.irec.org.au/farmer f/pdf 172/Direct%20drilling%20into%20stubble.pdf [Verified 22 April 2007].
15. Quince C, Lanzén A, Curtis TP, Davenport RJ, Hall N, Head IM, *et al*. Accurate determination of microbial diversity from 454 pyrosequencing data. Nature methods. 2009 Sep;6(9):639-641.